KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
UNIVERSITAS AIRLANGGA
Kampus C Mulyorejo Surabaya 60115 Telp. (031) 5914042, 5914043, Fax (031) 5981841
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SALINAN

KEPUTUSAN
REKTOR UNIVERSITAS AIRLANGGA
NOMOR 346/UN3/2020

TENTANG

PELAKSANAAN PENELITIAN INTERNAL UNIVERSITAS AIRLANGGA HIBAH RESEARCH GROUP, HIBAH RISET MANDAT, RISET KOLABORASI MITRA LUAR NEGERI, PENELITIAN UNGGULAN FAKULTAS, PENELITIAN DOSEN PEMULA DAN *ARTICLE REVIEW* PROGRAM TAHUN 2020

REKTOR UNIVERSITAS AIRLANGGA,

Menimbang : a. bahwa sesuai hasil seleksi proposal penelitian hibah riset mandat, penelitian unggulan fakultas dan penelitian dosen pemula Universitas Airlangga Tahun 2020 sebagai salah satu wujud dari pelaksanaan tridharma perguruan tinggi, maka perlu menetapkan para peneliti dan judul penelitian dimaksud;

b. bahwa berdasarkan pertimbangan sebagaimaan dimaksud pada huruf a, perlu menetapkan Keputusan Rektor tentang Pelaksanaan Penelitian Internal Universitas Airlangga Hibah Research Group, Hibah Riset Mandat, Riset Kolaborasi Mitra Luar Negeri, Penelitian Unggulan Fakultas, Penelitian Dosen Pemula Dan *Article Review* Program Tahun 2020;

Mengingat : 1. Undang–Undang Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional (Lembaran Negara Republik Indonesia Tahun 2003 Nomor 78, Tambahan Lembaran Negara Nomor 4301);
2. Undang–Undang Nomor 12 Tahun 2012 tentang Pendidikan Tinggi (Lembaran Negara Republik Indonesia Tahun 2012 Nomor 158, Tambahan Lembaran Negara Tahun 2012 Nomor 5336);
3. Peraturan Pemerintah Nomor 57 Tahun 1954 tentang Pendirian Universitas Airlangga di Surabaya sebagaimana telah diubah dengan Peraturan Pemerintah Nomor 3 Tahun 1955 tentang Pengubahan Peraturan Pemerintah Nomor 57 Tahun 1954 (Lembaran Negara Republik Indonesia Tahun 1954 Nomor 99 Tambahan Lembaran Negara Nomor 695 juncto Lembaran Negara Republik Indonesia Tahun 1955 Nomor 4 Tambahan Lembaran Negara Nomor 748);

4. Peraturan Pemerintah Nomor 37 Tahun 2009 tentang Dosen (Lembaran Negara Republik Indonesia Tahun 2009 Nomor 76, Tambahan Lembaran Negara Republik Indonesia Nomor 5007);
5. Peraturan Pemerintah Nomor 4 Tahun 2014 tentang Penyelenggaraan Pendidikan Tinggi dan Pengelolaan Perguruan Tinggi (Lembaran Negara Republik Indonesia Tahun 2014 Nomor 16, Tambahan Lembaran Negara Nomor 5500);
6. Peraturan Pemerintah Nomor 30 Tahun 2014 tentang Statuta Universitas Airlangga (Lembaran Negara Republik Indonesia Tahun 2014 Nomor 100, Tambahan Lembaran Negara Nomor 5535);
7. Peraturan Pemerintah Nomor 8 Tahun 2020 tentang Perubahan Atas Peraturan Pemeerintah Nomor 26 Tahun 2015 tentang Bentuk dan Mekanisme Pendanaan Perguruan Tinggi Negeri Badan Hukum (Lembaran Negara Republik Indonesia Tahun 2020 Nomor 28, Tambahan Lembaran Negara Republik Indonesia Nomor 6461);
8. Keputusan Majelis Wali Amanat Universitas Airlangga Nomor 1032/UN3.MWA/K/2015 tentang Pengangkatan Rektor Universitas Airlangga Periode 2015-2020;
9. Peraturan Rektor Universitas Airlangga Nomor 39 Tahun 2017 tentang Perubahan Atas Peraturan Rektor 42 Tahun 2016 tentang Organisasi dan Tata Kerja Universitas Airlangga;
10. Peraturan Rektor Universitas Airlangga Nomor 3 Tahun 2019 tentang Perubahan Kedua Atas Peraturan Rektor Nomor 27 Tahun 2018 tentang Pedoman Pendidikan Universitas Airlangga;
11. Keputusan Rektor Universitas Airlangga Nomor 1280/UN3/2015 tentang Pembentukan Lembaga Penelitian dan Inovasi;
12. Keputusan Rektor Universitas Airlangga Nomor 1285/UN3/2015 tentang Pengangkatan Ketua pada Lembaga dan Kepala Perpustakaan di Lingkungan Universitas Airlangga.

Memperhatikan : Surat Ketua lembaga penelitian dan Inovasi Universitas Airlangga Nomor 398/UN3.14/LT/2019, tanggal 21 Maret 2019, perihal Permohonan SK tentang Pelaksanaan Penelitian Internal Universitas Airlangga Tahun 2019.

MEMUTUSKAN :

MENETAPKAN : **KEPUTUSAN REKTOR TENTANG PELAKSANAAN PENELITIAN INTERNAL UNIVERSITAS AIRLANGGA HIBAH RESEARCH GROUP, HIBAH RISET MANDAT, RISET KOLABORASI MITRA LUAR NEGERI, PENELITIAN UNGGULAN FAKULTAS, PENELITIAN DOSEN PEMULA DAN *ARTICLE REVIEW* PROGRAM TAHUN 2020.**

KESATU : Menetapkan hasil seleksi proposal penelitian internal Universitas Airlangga Hibah Research Group, Hibah Riset Mandat, Riset Kolaborasi Mitra Luar Negeri, Penelitian Unggulan Fakultas, Penelitian Dosen Pemula Dan *Article Review* Program Tahun 2020.

KEDUA : Penerima Hibah Research Group, Hibah Riset Mandat, Riset Kolaborasi Mitra Luar Negeri, Penelitian Unggulan Fakultas, Penelitian Dosen Pemula Dan *Article Review* Program Tahun 2020 sebagaimana dimaksud pada diktum KESATU sebanyak 7 (tujuh) judul Hibah *Research Group*, 53 (lima puluh tiga) judul Hibah Riset Mandat dan Hibah Riset Mandat Dosen Muda, dan 50 (lima puluh) judul Riset Kolaborasi Mitra Luar Negeri, 205 (dua ratus lima) judul Penelitian Unggulan Fakultas, 92 (sembilan puluh dua) judul Penelitian Dosen Pemula, 24 (dua puluh empat) judul *Article Review* dengan susunan nama tim peneliti sebagaimana tercantum dalam lampiran yang merupakan bagian tidak terpisahkan dari Keputusan Rektor ini.

KETIGA : Biaya untuk pelaksanaan penelitian sebagaimana dimaksud pada diktum KEDUA adalah:

1. Hibah Research Group sebesar Rp 3.500.000.000 (tiga milyar Rupiah) dibebankan pada dana dibebankan pada dana RKAT Lembaga Penelitian dan Inovasi;
2. Hibah Riset Mandat dan Hibah Riset Mandat Dosen Muda sebesar Rp.11.630.325.650 (sebelas milyar enam ratus tiga puluh juta tiga ratus dua puluh lima ribu enam ratus lima puluh rupiah) dibebankan pada dana RKAT Lembaga Penelitian dan Inovasi;
3. Riset Kolaborasi Mitra Luar Negeri sebesar Rp 4.517.799.492 (empat milyar lima ratus tujuh belas juta tujuh ratus sembilan puluh sembilan ribu empat ratus sembilan puluh dua rupiah) dibebankan pada dana RKAT Lembaga Penelitian dan Inovasi;
4. Penelitian Unggulan Fakultas sebesar Rp. 7.321.435.400 (tujuh milyar tiga ratus dua puluh satu juta empat ratus tiga puluh lima ribu empat ratus rupiah) dibebankan pada RKAT masing-masing Fakultas;
5. Penelitian Dosen Pemula sebesar Rp. 2.105.323.750 (dua milyar seratus lima juta tiga ratus dua puluh tiga ribu tujuh ratus lima puluh rupiah) dibebankan pada RKAT masing-masing Fakultas;
6. *Article Review* Program sebesar Rp 1.197.887.257 (satu milyar seratus sembilan puluh tujuh juta delapan ratus delapan puluh tujuh ribu dua ratus lima puluh tujuh rupiah) dibebankan pada dana RKAT Lembaga Penelitian dan Inovasi.

KEEMPAT : Dalam melaksanakan tugasnya, penerima dana penelitian sebagaimana dimaksud pada diktum KEDUA, bekerja secara jujur dan transparan dengan berpedoman pada ketentuan peraturan perundang-undangan yang berlaku, serta bertanggungjawab kepada Rektor melalui Dekan pada Fakultas masing-masing.

KELIMA : Jangka waktu pelaksanaan penelitian sebagaimana dimaksud pada diktum KESATU berlaku sampai 31 Desember 2020.

KEENAM : Keputusan Rektor ini mulai berlaku surut sejak 1 maret 2020.

Salinan disampaikan Yth:
1. Pimpinan Unit Kerja di Lingkungan Unair
2. Yang bersangkutan

Ditetapkan di Surabaya
pada tanggal 27 Maret 2020

REKTOR,

ttd

MOHAMMAD NASIH
NIP.196508061992031002

Salinan sesuai dengan aslinya
Sekretaris Universitas,

KOKO SRIMULYO
NIP 196602281990021001

LAMPIRAN I KEPUTUSAN REKTOR UNIVERSITAS AIRLANGGA
NOMOR : 346/UN3/2020, TANGGAL 27 MARET 2020
TENTANG : PELAKSANAAN PENELITIAN INTERNAL UNIVERSITAS AIRLANGGA HIBAH RESEARCH GROUP, HIBAH RISET MANDAT, RISET KOLABORASI MITRA LUAR NEGERI, PENELITIAN UNGGULAN FAKULTAS, PENELITIAN DOSEN PEMULA DAN ARTICLE REVIEW PROGRAM TAHUN 2020

DAFTAR PROPOSAL RISET KOLABORASI MITRA LUAR NEGERI YANG LOLOS UNTUK DIDANAI TAHUN 2020

NO	TIM PENELITI	NIP	DOSEN NON UNAIR		NIM	SKEMA PENELITIAN	Fakultas / Nama Research Group	JUDUL PENELITIAN	DANA
1	RR. Retno Widyowati S.Si., Apt., M.Pharm (ketua), Suciati S.Si. Apt., M.Phil, PhD , Dr. Aty Widyawaruyanti, dra., Apt., M.Si.	197701052002122002 , 197911042005012001, 196204261990022001,	Prof Hsin-I Chang, PhD,	Saarah Khairunnisa, Eva Melisa Damayanti,	`051611133056, `051611133045,	Riset Kolaborasi Mitra Luar Negeri	Farmasi / NATURAL PRODUCT DRUG DISCOVERY	EKSTRAK TANDUK RUSA MENGINDUKSI EKSPRESI OSTEOGENESIS DAN GEN INFLAMASI MELALUI EFEK PROTEIN MORFOGENETIK TULANG	Rp 100.000.000
2	Prof. Dr. Chiquita Prahasanti S. drg., Sp.Perio (K) (ketua), Prof. Dr. Diah Savitri Ernawati, drg., M.Si., Sp.PM Tania Saskianti, drg., Ph.D., Sp.KGA.	`195809091985032001 ,  `196004291985032001, 197701132005012001,	Masami Kanawa, Kotaro Tanimoto,	Alexander Patera Nugraha, Betadion Rizki,	`011817017345, `011717017322,	Riset Kolaborasi Mitra Luar Negeri	Kedokteran Gigi / Tissue Engineering & Regenerative Medicine	Finding Functional Stem Cell from Exfoliated Deciduous Teeth by Analizing Its Molecular Markers for Alveolar Bone Tissue Regenerative Therapy	Rp 100.000.000
3	Dwi Kusuma WaHYUNI S.Si., M.Si. (ketua), Prof. H. Hery Purnobasuki, M.Si., Ph.D Dr. Junairiah, M.Kes	`197701152006042002 , `196705071991021001, 197107142002122002,	Assoc. Prof. Sehanat Prasongsuk, Ph.D,	Galuh Ayu Rakashiwi, Bruni Flaranda Yoku, Dani Tri Indriati, Mochammad Ilham, Siti Rizqiyatul Mukarromah,	`081711433030, `081711433095, `081711433076, `081711433022, `081711433071,	Riset Kolaborasi Mitra Luar Negeri	Sains dan Teknologi / Biodiversitas dan budidaya tumbuhan tropis	ANALISA STRUKTUR MORFO-ANATOMI, DNA BARCODE DAN PROFIL METABOLIT Sonchus rvensis L. AND Pterocarpus sp.	Rp 100.000.000
4	Dr. Sri Wigati Mardi Mulyani drg., M.Kes. (ketua), M. Gandul Atik Yuliani, drh., M.Kes.	`196601011991032003 , `197107161999032001,	Dr. Rima Parwati Sari, drg., MKes., Dr. Rajesh Ramasamy,	RP. Arief Rakhman, Muhammad Mulky Sulaiman Hajj,	`091824353002, `091914353006,	Riset Kolaborasi Mitra Luar Negeri	Kedokteran Gigi / Tissue Engineering & Regenerative Medicine	Perbedaan Potensi Differensiasi Menjadi Odontoblast dan Ekspresi VEGF pada Human Dental Pulp Mesenchymal Stem Cells (DP-MSC) dan Human Bone Marrow Mesenchymal Stem Cells (BM-MSC) (Penelitian In Vitro)	Rp 100.000.000
5	Tutik Sri Wahyuni S.Si., Apt., M.Si.,Ph.D (ketua), Prof. Dr. Achmad Fuad, drs., MS, Apt. Dr. Aty Widyawaruyanti, dra., Apt., M.Si.	`197710252006042003 , `195212121981031009, 196204261990022001,	Chie Aoki Utsubo,	Putri Dwi Widowati, Nurullia Tanjung,	`051611133023, `051611133027,	Riset Kolaborasi Mitra Luar Negeri	Farmasi / NATURAL PRODUCT DRUG DISCOVERY	Mekanisme Hambat Dan Fraksinasi Ekstrak Aktif Anti Virus Hepatitis B dan C	Rp 100.000.000
6	Agustono, Ir., M.Kes., Muhamad Amin S.Pi., M.Sc., Ph.D. (ketua), Prayogo, S.Pi., M.P.,	195706301986011001, `197505222003121002, `198110102019083101 ,	Dr. Nurul Nadiah Binti Mohd Firdaus Hum,	M. Giano Fadhilah, Zulfa Arofatul Jannah,	`141811133072, `141711133065,	Riset Kolaborasi Mitra Luar Negeri	Perikanan dan Kelautan / Fish Nutrition	ENHANCING AQUAPONIC PERFORMANCES USING MICROBIAL SYSTEM FOR SUSTAINABLE AND ECO-FRIENDLY AQUACULTURE	Rp 100.000.000
7	I Gede Wahyu Wicaksana S.IP., M.Si. PhD (ketua), Annisa Pratamasari, S.Hub.Int., M.Sc	197906022007101001 198807232016113201,	Professor Mark Beeson,	Agastya Wardhana, Probo Darono Yakti,	`071814553014, `071814553009,	Riset Kolaborasi Mitra Luar Negeri	Ilmu Sosial dan Ilmu Politik / Centre for Global and Startegic Studies (CSGS)	Foreign Policy and Strategic Culture in the Changing Asia-Pacific Order: An Indonesian Perspective	Rp 100.000.000
8	Prof. Dr. Mochamad Lazuardi M.Si., Drh (ketua), Dr. Suharjono, drs., MS Prof. Dr. Jenny Sunariani, drg., M.S. Dr. Lilik Maslachah, drh., M.Kes Dr. Rahmi Sugihartuti, drh., M.Kes.	`195812181987111001,  `195212221982031001, `195302071981032001, `196803111993032001, `196702211994032002,	Prof. Chi-Hsien Chien,Dr. Jie-Long He,	Mirtanti Kiswandi Putri, Moh. Sukmanadi, Natasya Oktaviani Putri, Aulia Rifda Prasasti Purnomo,	`061711133048, `061727117303, `021911133078, `021911133085,	Riset Kolaborasi Mitra Luar Negeri	Kedokteran Hewan / ILMU FARMASI VETERINER	Formulasi Progesterone Like-Effect dan vehikulum liposom untuk menghasilkan sediaan bio-aktif parenteral lepas lambat pada tikus.	Rp 100.000.000

NO	TIM PENELITI	NIP	DOSEN NON UNAIR		NIM	SKEMA PENELITIAN	Fakultas / Nama Research Group	JUDUL PENELITIAN	DANA
9	Prof. Dr. Tri Martiana, dr., M.S. (ketua), Dr. Indriati Paskarini, S.H., M.Kes.	`195603031987012001 , `196604111991032001,	Prof. Juliana J, Ph.D,Assoc. Prof. Dr Khadizah Haji Abdul Mumin,	Firman Suryadi Rahman, Alfian Suryadi Rahman,	`101817087330, `051811133038,	Riset Kolaborasi Mitra Luar Negeri	Kesehatan Masyarakat / Occupational Health and Safety Management	Indeks Prediksi Gangguan Kehamilan Pada Pekerja Wanita di Kawasan Industri Kabupaten Sidoarjo	Rp 100.000.000
10	Dr. Dian Agustin Wahjuningrum drg., SpKG (ketua), Prof. Dr. Latief Mooduto, drg., Sp.KG., M.S. Ari Subiyanto, drg., M.Kes., Sp.KG.	`197108201999032001 , `195209071978031001, `195701071983031003,	Dr. Anuj Bhardwaj,Abdullah Hasib,	Syania Edinda Febriyanti, Awalia Aprilizahrani Patiran,	`021711133056, `021711133078,	Riset Kolaborasi Mitra Luar Negeri	Kedokteran Gigi / Tissue Engineering & Regenerative Medicine	PENINGKATAN KAPASITAS OSTEOINDUKSI CHITOSAN SCAFFOLD MELALUI SEEDING HUMAN ADIPOSE-DERIVED MESENCHYMAL STEM CELL (HADMSC) PADA BONE DEFECT	Rp 100.000.000
11	Erwin Sutanto S.T., M.Sc. (ketua), Yhosep Gita Yhun Yhuwana, S.Si., M.T	`198012312015041002 , `197309042006041001,	Guillermo EscrivÃ¡-EscrivÃ¡, Muhammad Aziz,	Stefi Sari Kusumaningtyas, Hammam Abror Ali,	`081711733018, `151711613012,	Riset Kolaborasi Mitra Luar Negeri	Sains dan Teknologi / Medical Safety Device	Pembelajaran Mesin terhadap Pengukuran Arus Bocor di Rumah Sakit	Rp 100.000.000
12	Dr. Moses Glorino Rumambo Pandin M.Si.,M.Psi., M.Phil., Psi. (ketua), Yulia Indarti, S.S., M.A. Prof. Dr. Hj. Sri Iswati, SE., M.Si, Prof. Dr. Subagyo, Drs., M.S.	`197011112007011002, `197807272003122001, `196311211991032001, `195301261983031001,	Prof. Hanita Hasan, Ph.D, Hema Rosheny, Sulih Priyono,	Bagus Adhi Wicaksono, Yulia Ariana Swasti Longge, Laurensia Nindi Putri Pamungkas,	`081911633078, `151910513024, `151910513040,	Riset Kolaborasi Mitra Luar Negeri	Sekolah Pascasarjana / Pengembangan Sumber Daya Manusia	Peningkatan Kualitas Budaya Penelitian dan Publikasi Sekolah Pascasarjana Melalui Kerjasama dengan Mitra Luar Negeri	Rp 99.800.000
13	Dr. Muhammad Atoillah Isfandiari, dr., M.Kes. (ketua) Laura Navika Yamani, S.Si., M.Si., Ph.D. Prof. Dr. Afaf Baktir, M.S.	`197603252003121002, `198601082018032001, `195610141983032001,	DR. MUHD RIDZUAN BIN PAUZI,	Salsabila Shalihah Danar Putri, Ainun Azizah Ramdhani,	`101611133151, `101611133118,	Riset Kolaborasi Mitra Luar Negeri	Kesehatan Masyarakat / Tropical Diseases, Infectious Diseases, and Herb	EKSTRAK DAUN SIRIH DALAM ETANOL SEBAGAI ANTI KANDIDIASIS YANG DISEBABKAN CANDIDA TROPICALIS DAN CANDIDA GLABRATA	Rp 100.000.000
14	Devi Rianti drg., M.Kes (ketua), Prof. Dr. Anita YULIATI, drg., M.Kes. Tansza Permata Setiana Putri, drg., Ph.D.	`196309071990022001 , `195807091985032001, `198909282019086201,	Dr. Ir. Adriyansyah Syahrom, M Eng.,	Rania Vivian Nathania, Geo Fanny,	`021711133129, `021711133130,	Riset Kolaborasi Mitra Luar Negeri	Kedokteran Gigi / Tissue Engineering & Regenerative Medicine	Sintesis dan karakteristik komposit scaffold kitosan-gelatin-karbonat apatit berbasis batu kapur sebagai kandidat biomaterial regenerasi tulang	Rp 100.000.000
15	Dr. Fatmawati MSi. (ketua), Dr. Windarto, M.Si Cicik Alfiniyah, M.Si., Ph.D	`197307041998022001 , `197711042003121001, `198604122008122003,	Ebenezer Bonyah, Ph.D, Dr. Muhammad Altaf Khan,	Fitri Elfritasari, Deden Cahya Maulana,	`081611233036, `081611233114,	Riset Kolaborasi Mitra Luar Negeri	Sains dan Teknologi / Modelling System Group	Kajian Model Epidemi dalam Rangka Pencegahan dan Penanggulangan Penyakit Menular: Studi Kasus Tuberkulosis dan Demam Berdarah Dengue	Rp 100.000.000
16	Amalia Rizki SE., M.Si., Ak. (ketua), Khusnul Prasetyo,SE.,MM.,Ak.	`197604122003122003 , `198012222003121001,	Dr Yuningsih CPA,	Yohanes Annanto Herbawono, Achmad Amanu Husrizal F,	`151710613064, `041611333256,	Riset Kolaborasi Mitra Luar Negeri	Ekonomi dan Bisnis / Center for Corporate and Financial Reporting	Presidential and Legislative Election in Indonesia: An Event Study.	Rp 100.000.000
17	Sulis Bayusentono dr., M.Kes., Sp.OT. (ketua), Sri Andreani Utomo, dr. Sp.Rad(K) Dr. Irwanto, dr., Sp.A(K) Nurul Kusuma Wardani, dr.,Sp.KFR. Dr. Rosy Setiawati, dr., Sp.Rad(K) Dr. Prastiya Indra Gunawan, dr., Sp.A	`197709102005011002 , `195709052016016201, `196502272016016101, `198312032015042002, `197602152008012012, `197604292009121001,	dr. Muh. Ihsan Kitta, Sp. OT, dr. Hendra Cahaya Kumara, Sp. OT, M.Kes,	Prima Hari Nastiti, Vivi Irma Pratiwi, Henry Wicaksono,	`011928116306, `011728176301, `011618116301,	Riset Kolaborasi Mitra Luar Negeri	Kedokteran / ARTERIA (Airlangga Research Unit for Education and Application)	Uji Validasi Pengukuran Sudut Anteversi Femur Menggunakan Software FemoraÃ® Berbasis Pemeriksaan Imaging Radiography Konvensional 2D Femur Pada Populasi Di Indonesia	Rp 100.000.000
18	Ira Nurmala, S.KM., M.PH., Ph.D (ketua), Muthmainnah, S.KM., M.Kes. Pulung Siswantara, S.KM, M.Kes.	`197710172003122001 , `198806212015042005,` 198204242005011001,	Assoc. Prof. Neil Harris., Ph.D, Dr. Rachmat Hargono, dr. MS. M.PH,	Ratna Dwicahyaningtyas, Dian Tami Wahyuningtyas,	`101611133100, `101611133223,	Riset Kolaborasi Mitra Luar Negeri	Kesehatan Masyarakat / Inovasi Komunikasi, Informasi dan Edukasi Kesehatan	PERAN STAKEHOLDER DALAM PENGEMBANGAN MEDIA PROMOSI KESEHATAN REMAJA (COMPARISON STUDY INDONESIA-AUSTRALIA)	Rp 99.970.000

No	TIM PENELITI	KETUA PENELITI	NIP KETUA PENELITI	SKEMA	Fakultas	JUDUL PENELITIAN	DANA
23	Muhammad Miftahussurur, dr., Sp.PD., M.Kes., Ph.D., FINASIM	Muhammad Miftahussurur, dr., Sp.PD., M.Kes., Ph.D., FINASIM	197909292008121003	Article Review	FK	Perawatan Paliatif pada Stadium Akhir Penderita Kanker Kolorektal: Metode Terbaik Melalui Terapi Komplementer	Rp47.887.257
24	Iman Harymawan, S.E., MBA., Ph.D Yuanita Intan Paramitasari	Iman Harymawan, S.E., MBA., Ph.D	198404202008121005	Article Review	FEB	Corporate Social Responsibility (CSR) Research in Top Tier Journal	Rp50.000.000
						TOTAL	**Rp1.197.887.257**

Salinan sesuai dengan aslinya
Sekretaris Universitas,

KOKO SRIMULYO
NIP 196602281990021001

Ditetapkan di Surabaya
REKTOR,

MOHAMMAD NASIH
NIP 196508061992031002

KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
UNIVERSITAS AIRLANGGA
LEMBAGA PENELITIAN DAN INOVASI
Kampus C Mulyorejo Surabaya 60115 - Telp. (031) 5995247 Fax. (0315923584
Website : http://lpi.unair.ac.id; E-mail : adm@lpi.unair.ac.id

KONTRAK PELAKSANAAN RISET KOLABORASI MITRA LUAR NEGERI UNIVERSITAS AIRLANGGA TAHUN 2020
Nomor : 416 /UN3.14/PT/2020

Pada hari ini **senin** tanggal lima bulan Agustus tahun dua ribu dua puluh, kami yang bertandatangan di bawah ini:

1. Prof. Drs. Hery Purnobasuki, M.Si., Ph.D : Ketua Lembaga Penelitian dan Inovasi Universitas Airlangga yang berkedudukan di Surabaya, dalam hal ini bertindak untuk dan atas nama Rektor Universitas Airlangga; selanjutnya disebut **PIHAK PERTAMA;**

2. Devi Rianti drg., M.Kes : Dosen Universitas Airlangga dalam hal ini bertindak sebagai pengusul dan Ketua Pelaksana Penelitian Tahun Anggaran 2020 untuk selanjutnya disebut **PIHAK KEDUA.**

PIHAK PERTAMA dan PIHAK KEDUA secara bersama-sama bersepakat mengikatkan diri dalam suatu Kontrak Pelaksanaan Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga Tahun 2020 dengan ketentuan dan syarat-syarat yang diatur dalam pasal-pasal berikut:

PASAL 1
DASAR HUKUM

Kontrak Pelaksanaan Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga Tahun 2020 ini berdasarkan kepada:

1. Rencana Kegiatan Anggaran Tahunan (RKAT) Lembaga Penelitain dan Inovasi Universitas Airlangga Tahun Anggaran 2020;

2. Keputusan Rektor Universitas Airlangga Nomor 346/UN3/2020, tanggal 27 Maret 2020, tentang Pelaksanaan Penelitian Internal Universitas Airlangga Hibah Reserch Group, Hibah Riset Mandat, Riset Kolaborasi Mitra Luar Negeri, Penelitian Unggulan Fakultas, Penelitian Dosen Pemula dan *Article Review* Program Tahun 2020.

PASAL 2
HAK DAN KEWAJIBAN

(1) PIHAK PERTAMA memberi tugas kepada PIHAK KEDUA, dan PIHAK KEDUA menerima tugas sebagai penanggungjawab pelaksanaan Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga Tahun 2020 dengan judul:

" Sintesis dan karakteristik komposit scaffold kitosan-gelatin-karbonat apatit berbasis batu kapur sebagai kandidat biomaterial regenerasi tulang "

b) Pembayaran Tahap Kedua sebesar **30 %** dari total bantuan dana kegiatan yaitu 30% XRp nominal **dana penelitian yang disetujui** = Rp **30.000.000** (Tiga Puluh Juta Rupiah) dibayarkan setelah PIHAK KEDUA menyelesaikan pekerjaan dan mengunggah semua berkas di *cyber campus*, berupa:

- Laporan Kemajuan Pelaksanaan Riset Kolaborasi Mitra Luar Negeri di unggah di *cyber campus* paling lambat **15 Agustus 2020**;
- Laporan Akhir Hasil Pelaksanaan Riset Kolaborasi Mitra Luar Negeri di unggah di *cyber campus* paling lambat **30 November 2020**;
- Artikel Ilmiah berdasarkan Laporan Akhir Riset Kolaborasi Mitra Luar Negeri;
- Rekapitulasi Keuangan 100% dalam format pdf.
- Laporan/bukti fisik penggunaan keuangan (SPj.) 100% sebanyak satu eksemplar eksemplar paling lambat **7 Desember 2020**;
- Bukti luaran yang dihasilkan berupa paper/Artikel Ilmiah yang telah terpublikasi *(publish/accepted)* di Jurnal Internasional terindeks Scopus Minimal Quartil 3 (Q3) paling lambat **17 Agustus 2021** dan telah mendapat persetujuan (*approval*) dari Ketua LPI.

(3) Pendanaan **Kontrak Penelitian** sebagaimana dimaksud pada ayat (2) dibayarkan kepada peneliti berdasarkan data sebagai berikut.

Nama Peneliti	:	**Devi Rianti drg., M.Kes**
Nomor Rekening	:	**0100891649**
Nama penerima pada rekening	:	**Devi Rianti**
Nama Bank	:	**BNI**
NPWP Perguruan Tinggi	:	**73.773.758.5-619.000**

(4) PIHAK KEDUA bertanggungjawab mutlak dalam pembelanjaan dana tersebut pada ayat (1) sesuai dengan proposal kegiatan yang telah disetujui dan berkewajiban untuk menyampaikan semua bukti-bukti pengeluaran dengan jumlah dana yang diberikan oleh PIHAK PERTAMA.

PASAL 5
PENGGANTIAN KEANGGOTAAN

Apabila PIHAK KEDUA tidak dapat melaksanakan Riset Kolaborasi Mitra Luar Negeri ini, maka PIHAK KEDUA wajib menunjuk pengganti ketua pelaksana Penelitian yang merupakan salah satu anggota tim setelah mendapat persetujuan tertulis dari Ketua Lembaga Penelitian dan Inovasi Universitas Airlangga;

PASAL 6
SANKSI

(1) Laporan hasil pelaksanaan penelitian sebagaimana dimaksud dalam Pasal 2 ayat (1) harus memenuhi ketentuan sebagaimana tercantum pada Panduan Pelaksanaan Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga Tahun 2020;

(2) Apabila sampai dengan batas waktu yang telah ditetapkan PIHAK KEDUA belum menyelesaikan tugasnya dan atau terlambat mengirim laporan Kemajuan dan atau terlambat mengirim laporan Akhir, maka PIHAK KEDUA dikenakan sanksi administratif;

(3) Apabila PIHAK KEDUA tidak dapat memenuhi kewajiban utama menghasilkan luaran minimal **publikasi** di Jurnal Internasional terindeks Scopus sebagaimana dimaksud dalam Pasal 2 ayat (3), maka akan diberikan sanksi mengembalikan dana yang telah diberikan secara proporsional.

(4) Apabila PIHAK KEDUA tidak dapat melaksanakan penelitian ini maka harus mengembalikan dana yang tidak terserap kepada Rektor Universitas Airlangga melalui PIHAK PERTAMA;

(5) Apabila di kemudian hari terbukti bahwa judul Penelitian sebagaimana dimaksud dalam Pasal 2 ayat (1) dijumpai adanya indikasi duplikasi dengan Penelitian lain dan/atau diperoleh indikasi ketidakjujuran/itikad kurang baik yang tidak sesuai dengan kaidah ilmiah, maka kegiatan Penelitian tersebut dinyatakan batal dan PIHAK KEDUA wajib mengembalikan dana seluruhnya Penelitian kepada Rektor Universitas Airlangga melalui PIHAK PERTAMA.

(6) Denda atau pengembalian dana sebagaimana tersebut di atas disetorkan ke Rektor Universitas Airlangga melalui PIHAK PERTAMA;

PASAL 7
PAJAK

PIHAK KEDUA berkewajiban menyetor pajak ke Kantor Pelayanan Pajak setempat yang berkenaan dengan kewajiban pajak berupa :

1. pembelian barang dan jasa dikenai PPN sebesar 10% dan PPh 23 sebesar 2%;
2. pajak–pajak lain sesuai ketentuan yang berlaku;
3. Pajak honorarium untuk non ketua dan non anggota peneliti sebesar 5% untuk yang memiliki NPWP dan 6% untuk yang tidak memiliki NPWP

PASAL 8
KEKAYAAN INTELEKTUAL

(1) Hak Kekayaan Intelektual yang dihasilkan dari pelaksanaan Riset Kolaborasi Mitra Luar Negeri ini diatur dan dikelola sesuai dengan peraturan dan perundang-undangan yang berlaku;

(2) Setiap publikasi, makalah, dan/atau ekspos dalam bentuk apapun yang berkaitan dengan hasil penelitian ini wajib mencantumkan **PIHAK PERTAMA** sebagai pemberi dana.

(3) Publikasi tidak boleh ***double counting*** dengan luaran kegiatan pendanaan penelitian yang lain.

(4) Hasil Hibah Penelitian berupa peralatan dan/atau alat yang dibeli dari kegiatan ini menjadi milik Universitas Airlangga yang dapat dihibahkan kepada institusi/lembaga/masyarakat melalui Berita Acara Serah Terima (BAST).

PASAL 9
PENYELESAIAN PERSELISIHAN

(1) Apabila terjadi perselisihan antara PIHAK PERTAMA dan PIHAK KEDUA dalam pelaksanaan kontrak ini, maka akan dilakukan penyelesaian secara musyawarah untuk mufakat dan apabila tidak tercapai penyelesaian secara musyawarah dan mufakat maka penyelesaian dilakukan melalui proses hukum yang berlaku dengan memilih domisili hukum di Pengadilan Negeri;

(2) Hal-hal yang belum diatur dalam perjanjian ini akan diatur kemudian oleh KEDUA BELAH PIHAK.

PASAL 10
KEADAAN MEMAKSA (*FORCE MAJEURE*)

(1) **PARA PIHAK** dibebaskan dari tanggung jawab atas keterlambatan atau kegagalan dalam memenuhi kewajiban yang dimaksud dalam Penugasan Penelitian disebabkan atau diakibatkan oleh peristiwa atau kejadian diluar kekuasaan **PARA PIHAK** yang dapat digolongkan sebagai keadaan memaksa (*force majeure*).

(2) Peristiwa atau kejadian yang dapat digolongkan keadaan memaksa (*force majeure*) dalam Penugasan Penelitian ini adalah bencana alam, wabah penyakit, kebakaran, perang, blokade, peledakan, sabotase, revolusi, pemberontakan, huru hara serta adanya tindakan pemerintah dalam bidang ekonomi dan moneter yang secara nyata berpengaruh terhadap pelaksanaan Penugasan Penelitian ini.

(3) Apabila terjadi keadaan memaksa (*force majeure*) maka pihak yang mengalami wajib memberitahukan kepada pihak lainnya secara tertulis, selambat-lambatnya dalam 7 (tujuh) hari kerja sejak terjadinya keadaan memaksa (*force majeure*), disertai dengan bukti-bukti yang sah dari pihak berwajib, dan **PARA PIHAK** dengan itikad baik akan segera membicarakan penyelesaiannya.

PASAL 11
PENUTUP

Surat Perjanjian Pelaksanaan Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga Tahun 2020 ini dibuat rangkap 2 (dua) bermeterai cukup sesuai dengan ketentuan yang berlaku, dan biaya meterai dibebankan kepada PIHAK KEDUA.

KEDUA

Devi Rianti drg., M.Kes
NIP. `196309071990022001

PIHAK PERTAMA

Prof. Drs. Hery Purnobasuki, M.Si., Ph.D
NIP. 196705071991021001

Mengetahui
Wakil Rektor 3 Universitas Airlangga,

Prof. Mochammad Amin Alamsjah, Ir., M.Si., Ph.D.
NIP. 197001161995031002

No : 14/RKMLN/thp-II/2020

SURAT PERTANGGUNGJAWABAN DANA PENELITIAN
UNIVERSITAS AIRLANGGA

Sesuai dengan : 1. U.U. Nomor 17 Tahun 2003 tentang Keuangan Negara;
2. U.U. Nomor 1 Tahun 2004 tentang Perbendaharaan Negara;
3. U.U. Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional;
4. U.U. Nomor 12 Tahun 2012 tentang Pendidikan Tinggi;
5. P.P. Nomor 57 Tahun 1954 tentang Pendirian Universitas Airlangga di Surabaya sebagaimana telah diubah dengan Peraturan Pemerintah nomor : 3 Tahun 1955 tentang pengubahan Peraturan Pemerintah Nomor : 1954;
6. P.P. Nomor 37 Tahun 2009 tentang Dosen;
7. P.P. Nomor 30 Tahun 2014 tentang Statuta Universitas Airlangga;
8. Peraturan Wali Amanat Universitas Airlangga.

Unit Kerja : 20800 Lembaga Penelitian Dan Inovasi
Penelitian DRPM Kemenristekdikti RI

Kode Kegiatan :
Kode Rekening :

Telah Terima : Rektor Universitas Airlangga

Terbilang Rp. : Tiga Puluh Juta Rupiah

Untuk Pembayaran : Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga Tahun 2020

Judul : Sintesis dan karakteristik komposit scaffold kitosan-gelatin-karbonat apatit *berbasis batu kapur sebagai kandidat biomaterial regenerasi tulang*

Sumber Dana : Universitas Airlangga Tahun Anggaran 2020

Termin : II / 30%

Ketua Peneliti : Devi Rianti drg., M.Kes

Jumlah : **Rp. 30.000.000**

Surabaya

Lunas Dibayar Bendahara

Wishnu Okky Pranadi Tirta
NIP. 199210232018013101

Ketua Peneliti

METERAI TEMPEL
43834AHF316459600
6000
ENAM RIBU RUPIAH

Devi Rianti drg., M.Kes
NIP. `196309071990022001

Mengetahui / Menyetujui
Atasan Langsung Bendahara

Prof. Hery Purnobasuki, Drs., M.Si., Ph.D.
NIP. 196705071991021001

No : 14/RKMLN/thp-I/2020

SURAT PERTANGGUNGJAWABAN DANA PENELITIAN
UNIVERSITAS AIRLANGGA

Sesuai dengan	:	1. U.U. Nomor 17 Tahun 2003 tentang Keuangan Negara; 2. U.U. Nomor 1 Tahun 2004 tentang Perbendaharaan Negara; 3. U.U. Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional; 4. U.U. Nomor 12 Tahun 2012 tentang Pendidikan Tinggi; 5. P.P. Nomor 57 Tahun 1954 tentang Pendirian Universitas Airlangga di Surabaya sebagaimana telah diubah dengan Peraturan Pemerintah nomor : 3 Tahun 1955 tentang pengubahan Peraturan Pemerintah Nomor : 1954; 6. P.P. Nomor 37 Tahun 2009 tentang Dosen; 7. P.P. Nomor 30 Tahun 2014 tentang Statuta Universitas Airlangga; 8. Peraturan Wali Amanat Universitas Airlangga.
Unit Kerja	:	2 0 8 0 0 Lembaga Penelitian Dan Inovasi Penelitian DRPM Kemenristekdikti RI
Kode Kegiatan	:	
Kode Rekening	:	

Telah Terima	:	Rektor Universitas Airlangga
Terbilang Rp.	:	Tujuh Puluh Juta Rupiah
Untuk Pembayaran	:	Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga Tahun 2020
Judul	:	Sintesis dan karakteristik komposit scaffold kitosan-gelatin-karbonat apatit *berbasis batu kapur sebagai kandidat biomaterial regenerasi tulang*
Sumber Dana	:	Universitas Airlangga Tahun Anggaran 2020
Termin	:	I / 70%
Ketua Peneliti	:	Devi Rianti drg., M.Kes
Jumlah	:	**Rp. 70.000.000**

Surabaya

Lunas Dibayar Bendahara

Ketua Peneliti

Wishnu Okky Pranadi Tirta
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Devi Rianti drg., M.Kes
NIP. `196309071990022001

Mengetahui / Menyetujui
Atasan Langsung Bendahara

Prof. Hery Purnobasuki, Drs., M.Si., Ph.D.
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SURAT PERNYATAAN TANGGUNGJAWAB MUTLAK

Hibah Riset Kolaborasi Mitra Luar Negeri 2020

No.: 14/RKMLN/Thp-II/2020

Yang bertanda tangan di bawah ini

1.	N a m a	:	Devi Rianti drg., M.Kes
2.	N I P	:	`196309071990022001
3.	Jabatan	:	Ketua Peneliti
4.	Fak/Lembaga	:	Fakultas Kedokteran Gigi Universitas Airlangga
5.	Sumber Dana	:	Damas Universitas Airlangga Tahun Anggaran 2020
6.	SK Rektor	:	346/UN3/2020 tanggal, 27 Maret 2020
7.	Nilai Kontrak	:	Rp 100.000.000,- (Seratus Juta Rupiah)
8.	Tahap II (30%)	:	Rp 30.000.000,- (Tiga Puluh Juta Rupiah)
9.	Kegiatan	:	Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga *Anggaran 2020*
10.	Judul	:	Sintesis dan karakteristik komposit scaffold kitosan-gelatin-karbonat apatit berbasis batu kapur sebagai kandidat biomaterial regenerasi tulang

Menyatakan dengan sesungguhnya bahwa :

1. Bertanggungjawab mutlak dalam pembelanjaan dana Hibah Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga Tahun Anggaran 2020 dan berkewajiban untuk menyimpan semua copy bukti-bukti pengeluaran dan Asli sesuai dengan jumlah dana yang diterima;
2. Berkewajiban mengembalikan sisa dana yang tidak dibelanjakan ke Kas Negara;
3. Berkewajiban memungut dan menyetor pajak-pajak sesuai ketentuan yang berlaku;
4. Bertanggungjawab penuh atas data administrasi pelaksanaan penerima dana Hibah Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga Tahun Anggaran 2020.

Demikian Surat Pernyataan ini saya buat dengan sebenarnya.

Ketua Peneliti,

Devi Rianti drg., M.Kes
NIP. `196309071990022001

SURAT PERNYATAAN TANGGUNGJAWAB MUTLAK

Hibah Riset Kolaborasi Mitra Luar Negeri 2020

No.: 14/RKMLN/Thp-I/2020

Yang bertanda tangan di bawah ini

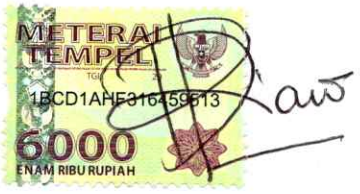
1.	N a m a	:	Devi Rianti drg., M.Kes
2.	N I P	:	`196309071990022001
3.	Jabatan	:	Ketua Peneliti
4.	Fak/Lembaga	:	Fakultas Kedokteran Gigi Universitas Airlangga
5.	Sumber Dana	:	Damas Universitas Airlangga Tahun Anggaran 2020
6.	SK Rektor	:	346/UN3/2020 tanggal, 27 Maret 2020
7.	Nilai Kontrak	:	Rp 100.000.000,- (Seratus Juta Rupiah)
8.	Tahap I (70%)	:	Rp 70.000.000,- (Tujuh Puluh Juta Rupiah)
9.	Kegiatan	:	Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga *Anggaran 2020*
10.	Judul	:	Sintesis dan karakteristik komposit scaffold kitosan-gelatin-karbonat apatit berbasis batu kapur sebagai kandidat biomaterial regenerasi tulang

Menyatakan dengan sesungguhnya bahwa :

1. Bertanggungjawab mutlak dalam pembelanjaan dana Hibah Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga Tahun Anggaran 2020 dan berkewajiban untuk menyimpan semua copy bukti-bukti pengeluaran dan Asli sesuai dengan jumlah dana yang diterima;
2. Berkewajiban mengembalikan sisa dana yang tidak dibelanjakan ke Kas Negara;
3. Berkewajiban memungut dan menyetor pajak-pajak sesuai ketentuan yang berlaku;
4. Bertanggungjawab penuh atas data administrasi pelaksanaan penerima dana Hibah Riset Kolaborasi Mitra Luar Negeri Universitas Airlangga Tahun Anggaran 2020.

Demikian Surat Pernyataan ini saya buat dengan sebenarnya.

Ketua Peneliti,



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IJIE

Journal homepage: http://penerbit.uthm.edu.my/ojs/index.php/ijie
ISSN : 2229-838X e-ISSN : 2600-7916

The International Journal of Integrated Engineering

The Characteristics, Swelling Ratio and Water Content Percentage of Chitosan-gelatin/limestone-based Carbonate Hydroxyapatite Composite Scaffold

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DOI: https://doi.org/10.30880/ijie.2022.14.02.003
Received 30 April 2021; Accepted 30 September 2021; Available online 02 June 2022

Abstract: The tissue engineering field has developed a scaffold that can be used to increase the bone regeneration process. Carbonate hydroxyapatite (CHA) is a well-known scaffold due to its human bones resembling components. The scaffold was synthesized from K, G, and limestone-based CHA using a freeze-drying method with K-G/CHA ratios (w/w) of 40:60, 30:70, 20:80, and 10:90. A Fourier transform infrared spectroscopy (FTIR), a scanning electron microscope-energy dispersive X-ray (SEM-EDX), and X-ray diffraction (XRD) were used to characterize the scaffold. The FTIR test showed some functional groups, such as hydroxyl, amide I, amide II, carbonate, and phosphate. The SEM-EDX test showed micropore (<50 um) and macropores (>50 um) structures as well as elements of C, N, O, Mg, Al, Si, P, and Ca. The XRD analysis obtained crystalline and amorphous particles. The water content percentage (WCP) values obtained were 61.29%, 64.30%, 67.71%, and 67.78%. The K-G/CHA composite scaffold with a ratio of 30:70 has ideal characteristics, a swelling ratio, and a water content percentage.

Keywords: Chitosan, gelatin, limestone-based carbonate hydroxyapatite, composite scaffold, medicine, swelling ratio

1. Introduction

Bone damage is one of the health problems that often occur in the field of dentistry. Bone destruction can be caused by periodontal disease, neoplastic disease, trauma, necrosis, or infection [1], [2]. Bones can be remodeled; however, severe fractures require surgical intervention to aid the healing process. In this case, a technique was employed to develop a 3D scaffold. The scaffold is combined with stem cells and growth factors to replace damaged tissue by supporting the differentiation of stem cells to new bone [3], [4]. The scaffold acts as a microenvironment that facilitates stem cells to attach. In addition, it may support cell proliferation that can induce bone formation. There are some requirements for an ideal scaffold such as biocompatible, biodegradable, osteoconductive, good porosity and it should have good mechanical properties [1], [5]. The scaffold's property is determined by the intrinsic properties and the combination of the chemical and physical properties of the material that constructs the scaffold [4].

The scaffold from chitosan, gelatin, and limestone-based Carbonate hydroxyapatite (CHA) was developed for application in the field of tissue engineering. Chitosan (K) is a polymer derived from chitin, which has a similar structure to glycosaminoglycan, which supports proliferation, the differentiation of osteoprogenitor cells, and bone formation [3], [6]. Chitosan can be applied clinically because of its good biocompatibility and biodegradation properties [7]. Gelatin

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(G) is a biopolymer resulting from the partial hydrolysis of collagen. Gelatin consists of arginine-glycine-aspartate (RGD) amino acid sequences, which support adhesion and cell migration, and it has good biocompatible and biodegradable properties [6]. Carbonate apatite is used in the field of bone tissue engineering because its content mostly resembles bone-building apatite compared to other calcium phosphates [8]. Carbonate apatite has osteoconductive and osteoinductive properties, and it can also stimulate osteogenesis with minimal immunological reactions [9–11].

The combination of chitosan and gelatin with carbonate apatite is expected to produce organic and inorganic compositions that resemble bone structures and produce good mechanical properties for implantation in bone defects [12]. The organic composition of bones consists of collagen and non-collagen components. The collagen component is represented by gelatin, while the non-collagen component is represented by chitosan [13]. In this study, we used CHA synthesized from Indonesian limestone, which is produced by Balai Besar Keramik Indonesia. Limestone contains calcium carbonate ($CaCO_3$), which can be used as a scaffold material in the form of apatite carbonate [14]. CHA is often used for scaffold materials because it has physicochemical properties, biocompatibility, and osteoconductivity is similar to inorganic components of bone [15]. The K-G/CHA composite scaffold was synthesized in four ratios (w/w), namely 40:60, 30:70, 20:80, and 10:90. These ratios are considered to be under the composition of the organic (22%) and inorganic (69%) components of bone with variations in the arithmetic series [12].

The K-G/CHA scaffold was synthesized by a freeze-drying method to obtain a porous scaffold [16]. The characteristics were analyzed using Fourier transform infrared spectroscopy (FTIR), a scanning electron microscope-energy dispersive X-ray (SEM-EDX), and X-ray diffraction (XRD). In addition, the swelling ratio and the water content percentage (WCP) analysis were also performed. The composition of the scaffold is important to produce the ideal scaffold [3]. The difference in the ratios of the scaffold component composition will affect the scaffold's characteristics. Thus, this study aimed to analyze the characteristics of various ratios of K-G/CHA scaffold and find the optimal ratios for the scaffold manufacture.

2. Materials and Methods

The materials used in this study were chitosan with a medium molecular weight (Sigma Aldrich 448877, USA), Bovine gelatin (Sigma Aldrich G9391, USA), CHA powder made from limestone produced by Balai Besar Keramik Indonesia (BBK Indonesia), natrium hydroxide (Biomedicine), acetic acid (Merck), aquadestilata (Duta Farma), and simulated body fluid (SBF Merck). The scaffold with a ratio of 40:60 (w/w) consists of 0.5 grams of chitosan, 0.5 grams of gelatin, and 1.5 grams of CHA. The scaffold with a ratio of 30:70 (w/w) consists of 0.375 grams of chitosan, 0.375 grams of gelatin, and 1.75 grams of CHA. The scaffold with a ratio of 20:80 (w/w) consists of 0.25 grams of chitosan, 0.25 grams of gelatin, and 2 grams of CHA. The scaffold with a ratio of 10:90 (w/w) consists of 0.125 grams of chitosan, 0.125 grams of gelatin, and 2.25 grams of CHA.

Gelatin was dissolved in 2 ml of 2% acetic acid by stirring at 50 ^{o}C. The CHA was mixed with 0.94 ml of distilled water and stirred until homogeneous. The diluted CHA was mixed with gelatin gel, and then chitosan powder was added to form a chitosan-gelatin gel and CHA. 0.5 ml of 0.1 M NaOH was added to neutralize the acid. The pH was checked to get the neutral pH (pH = 7), which was then added into the scaffold mold and frozen at -40 ^{o}C for 2 x 24 hours.

The functional groups of chitosan, gelatin, CHA, and K-G/CHA scaffold were analyzed using an FTIR (Thermo Scientific) with a wavelength of 400–4000 cm^{-1}. The resulting graph was then matched with the peak table. The XRD analysis was carried out using the X'Pert PRO PAN analytical tool. The monitor was rotated around the sample and set at an angle of 2θ to the incident flow. The results of this X-ray diffraction were imprinted on paper with a copper (Cu) radiation source with a nickel filter. An SEM-EDX analysis was obtained using EDAX-AMATEK, which was conducted at 100x and 500x magnification. In the SEM test, 10 pores at 100x magnification were randomly selected. The pore diameter was then measured using ImageJ software. The swelling analysis was carried out by weighing the initial weight of the scaffold (*Wi*), immersing the scaffold in distilled water for 24, 72, and 168 hours and then weighing it to get the final weight (*Wf*). The swelling value is calculated by the formula in Eq. 1.

$$Swelling = \frac{Wf-Wi}{Wi} \quad (1)$$

The WCP analysis was carried out by weighing the initial weight of the scaffold (*Wi*), immersing the scaffold in distilled water for 24, 72, and 168 hours and then weighing it to get the final weight (*Wf*). The WCP value is calculated by the formula in Eq. 2.

$$WCP = \frac{Wf-Wi}{Wf} \times 100\% \quad (2)$$

The data were analyzed using Saphiro-Wilk testing to see the normality of the data distribution and a Levene test to see the data homogeneity. If the data were normally distributed and homogeneous, it was continued with the one-way Anova test and Tukey's HSD. If the data were not normally distributed or homogeneous, they were analyzed using Kruskal Wallis and Mann Whitney. The values of $p < 0.05$ were considered statistically significant.

3. Results

3.1 Functional Group Analysis using FTIR

FTIR analysis was performed to analyze the presence of different functional groups for CHA BBK, chitosan, gelatin, and K-G/CHA scaffold, as shown in Fig. 1. It was found that CHA BBK has hydroxyl (-OH), carbonate (CO_3^{2-}), and phosphate (PO_4^{3-}) groups. The peak for the hydroxyl groups (-OH) bands at 3447.70 cm^{-1}, the carbonate groups (CO_3^{2-}) at 1424.90 cm^{-1}, and the phosphate groups (PO_4^{3-}) at 1086.78 cm^{-1}, 1026.73 cm^{-1}, and 961.64 cm^{-1} [17], [18]. Chitosan with a medium molecular weight has hydroxyl (-OH), C-H, amide I, amide II, and amine (C-N) functional groups. The peak for the hydroxyl groups (-OH) bands at 3293.93 cm^{-1}; the CH groups at 2873.88 cm^{-1}; the amide I groups at 1654.15 cm^{-1}, 1647.87 cm^{-1}, and 1637.14 cm^{-1}; the amide II groups at 1508.13 cm^{-1} and 1458.38 cm^{-1}; and the amine groups at 1149.20 cm^{-1} and 1023.57 cm^{-1} [17], [18].

In gelatin, there are hydroxyl groups (-OH), amide I, carboxylate (-COO), and amine functional groups. The peak for the hydroxyl groups (-OH) bands at 3271.25 cm^{-1} and 2935.17 cm^{-1}, the amide I groups at 1633.37 cm^{-1}, the carboxylate (-COO) groups at 1234.4 cm^{-1}, and the amine groups at 1077.98 cm^{-1} [17], [18]. The K-G/CHA scaffold with four different ratios showed the presence of the same functional groups, namely the hydroxyl (-OH) groups with peaks at around 3292.09–3447.43 cm^{-1}, the amide I groups at around 1654.37–1636.79 cm^{-1}, the amide II groups at around 1483.47–1482.31 cm^{-1}, the carbonate groups at around 1423.18–1420.81 cm^{-1}, and the phosphate groups at around 1086.88–961.29 cm^{-1}.

3.2 X-ray Diffraction (XRD) Analysis

XRD was performed to analyze the structural properties, as shown in Fig. 2. CHA BBK has clear peak patterns, indicating that it has a crystalline form. It showed a similar pattern with synthetic hydroxyapatite. The XRD patterns of chitosan showed that there are were two high peaks with a wide and sloping distance, which indicates that chitosan has a semi-crystalline form. The gelatin sample showed a sloping peak, indicating that gelatin has an amorphous form. The pattern of the K-G/CHA scaffold samples with 40:60 (w/w), 30:70 (w/w), 20:80 (w/w), and 10:90 (w/w) ratios were firm and sloping peaks. This pattern indicated that the scaffold form is a combination of being crystalline and amorphous.

3.3 Scanning Electron Microscopy-energy Dispersive X-ray (SEM-EDX) Analysis

Based on the SEM analysis, the K-G/CHA scaffold with ratios of 40:60 (w/w), 30:70 (w/w), 20:80 (w/w), and 10:90 (w/w) has pore sizes range of 30.42-282.7 µm, 40.59-153.8 µm, 43.71-441.0 µm, and 44.10-145.2 µm, respectively (Table 2).

Table 2 - The Pore size of various K-G/CHA scaffold ratios

No	K-G/CHA scaffold ratios	Pore size range	Mean	SD
1	40:60	30,42-282,7 µm	108,72 µm	75.27
2	30:70	40,59-153,8 µm	69,405 µm	35.32
3	20:80	43,71-441 µm	127,69 µm	118.67
4	10:90	44,10-145,2 µm	109,75 µm	37.77

Based on the results of the EDX analysis shown in Fig. 3–7, CHA BBK contained six elements, namely O, Mg, Al, Si, P, and Ca. Moreover, there were eight elements contained in the K-G/CHA scaffold, namely C, N, O, Mg, Al, Si, P, and Ca. The Ca/P ratio was calculated using the atomic percentages of Ca and P, which were obtained from the EDX analysis. It was found that CHA BBK has a Ca/P ratio of 1.81. After the CHA BKK was combined with chitosan and gelatin to form the K-G/CHA scaffold, it was found that the ratio of 40:60 (w / w) had the smallest Ca/P ratio (1.65) and the ratio of 20:80 (w/ w) had the largest Ca/P ratio (1.99) (Table 3).

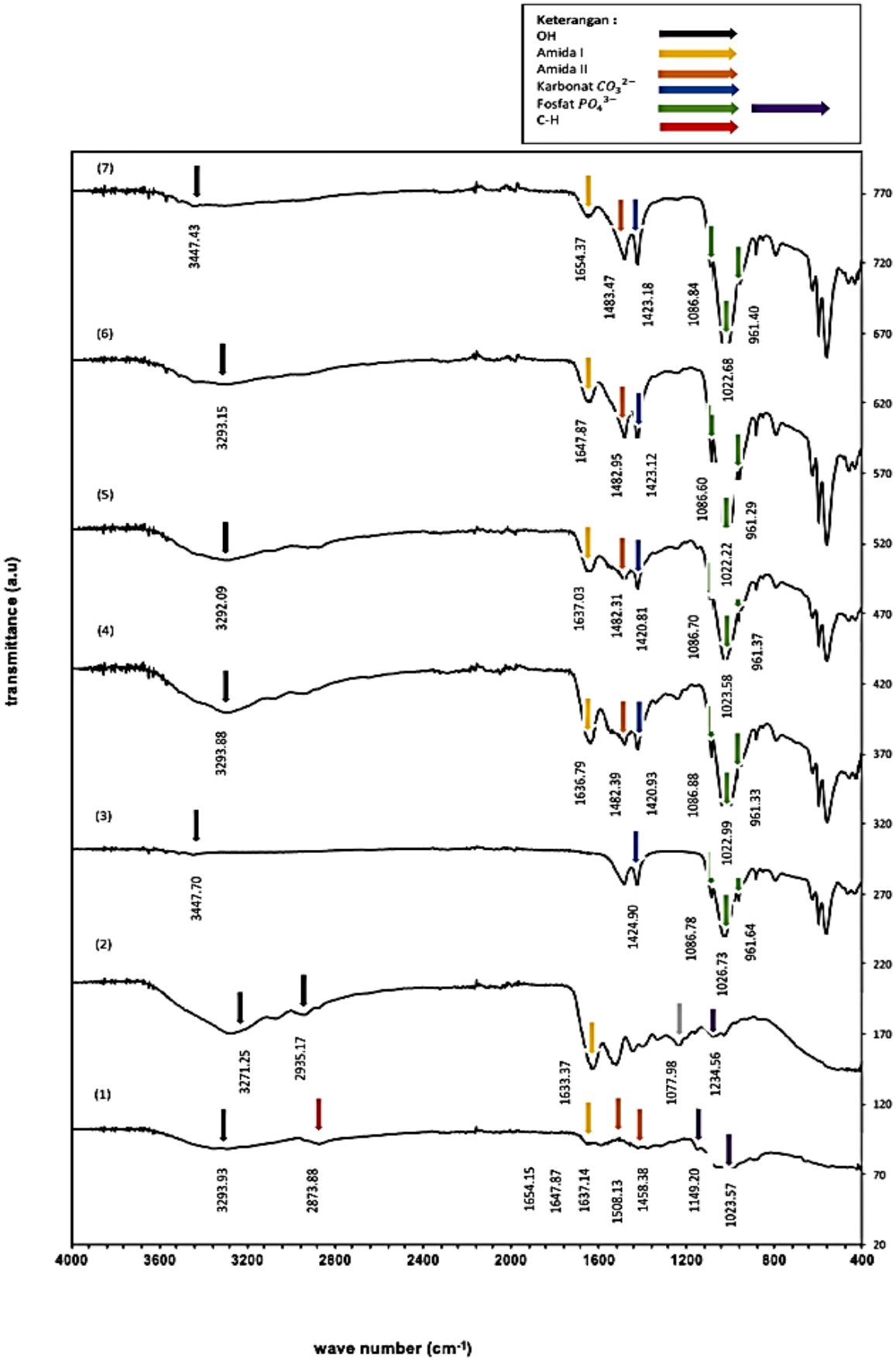


Fig. 1 - The FTIR pattern of chitosan (1), gelatin (2), and CHA BBK (3) K-G/CHA scaffold with ratios of 40:60 (4), 30:70 (5), 20:80 (6), and 10:90 (7)

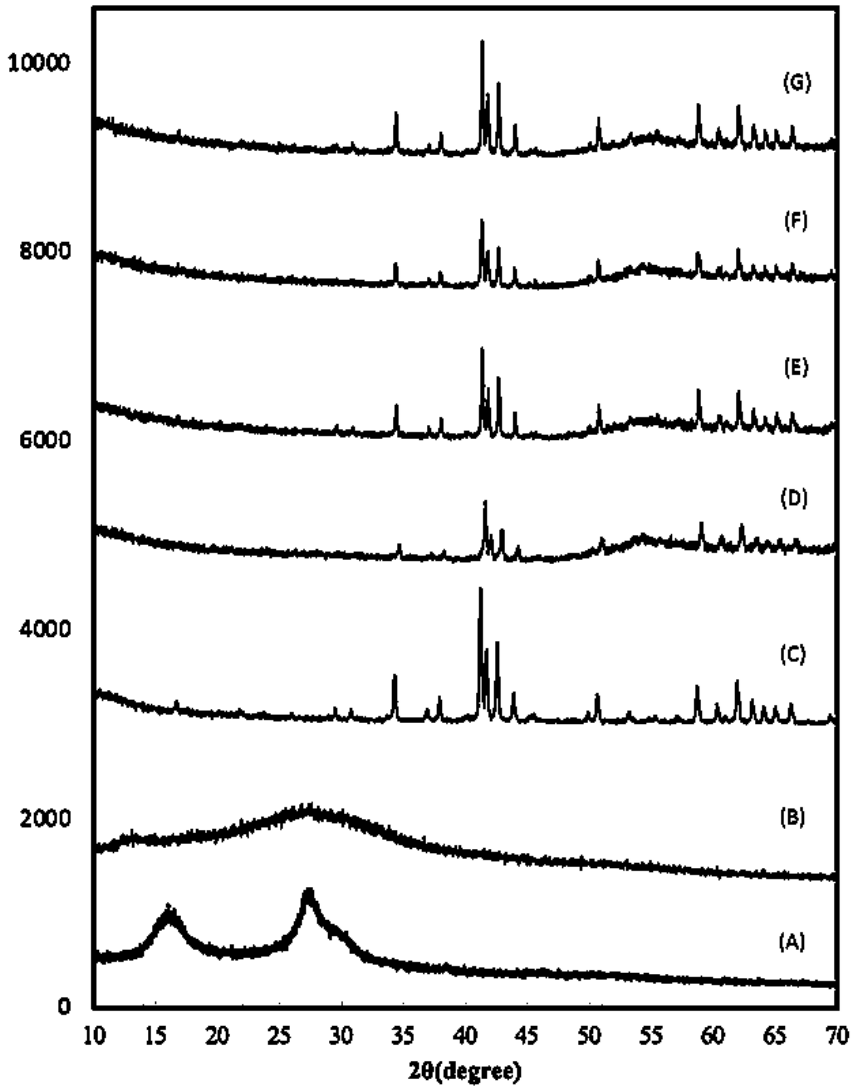


Fig. 2 - X-ray diffraction pattern of chitosan (A), gelatin (B), CHA BBK (C), and K-G/CHA scaffold with ratios of 40:60 (D), 30:70 (E), 20:80 (F), and 10:90 (G)

Table 3 - Energy dispersive X-ray (EDX) analysis at 100x magnification

Sample	Ca (At %)	P (At %)	Ca/P ratio
CHA BBK	26.43	14.59	1.81
K-G/CHA 40:60	15.92	09.65	1.65
K-G/CHA 30:70	18.02	10.66	1.69
K-G/CHA 20:80	20.44	10.27	1.99
K-G/CHA 10:90	21.41	11.57	1.85

3.4 Swelling Ratio and Water Content Percentage (WCP) Analysis

Figures 8 and 9 showed that the less CHA composition, the greater the mean value of the WCP. On the other hand, the duration of immersion affects the swelling ratio, the longer the immersion duration, the higher the swelling ratio. The results of the normality test using the Saphiro-Wilk test and the homogeneity using the Levene test showed that the swelling data were normally distributed and homogeneous ($p > 0.05$). The statistical tests using the one-way ANOVA showed that there is a significant difference ($p = 0.000$) between the K-G/CHA scaffold ratio and the swelling ratio value, indicating that the higher the CHA composition, the lower the swelling ratio value. Using Tukey's HSD statistical test, a significant difference was found between the K-G/CHA scaffold ratios of 10:90, 30:70, and 40:60 also between the ratios of 20:80 and 40:60 ($p < 0.05$). There was a significant difference between 24, 72, and 168 hours of immersion ($p < 0.05$).

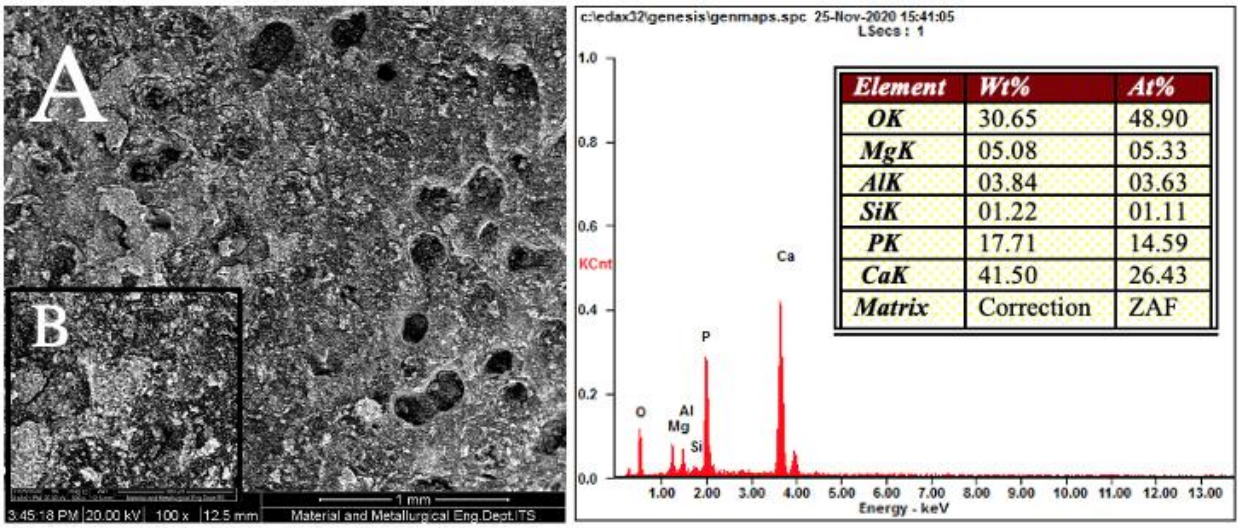


Fig. 3 - The SEM-EDX analysis shows the surface morphology and composition of CHA BBK at a magnification of 100x (A) and 500x (B)

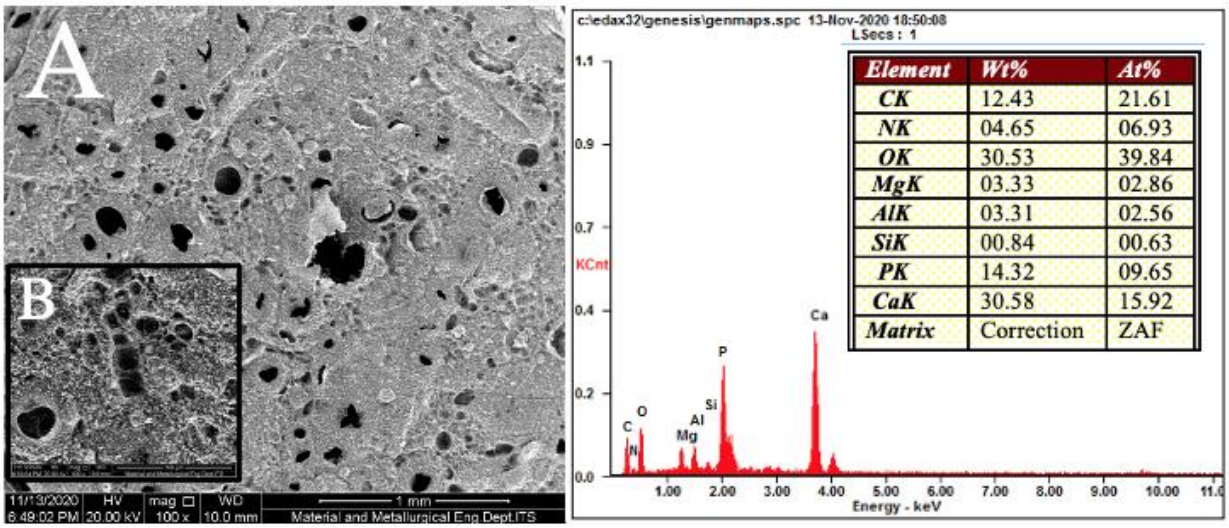


Fig. 4 - The SEM-EDX analysis shows the surface morphology and composition of the K-G/CHA40:60 (w/w) scaffold at 100x (A) and 500x (B) magnification

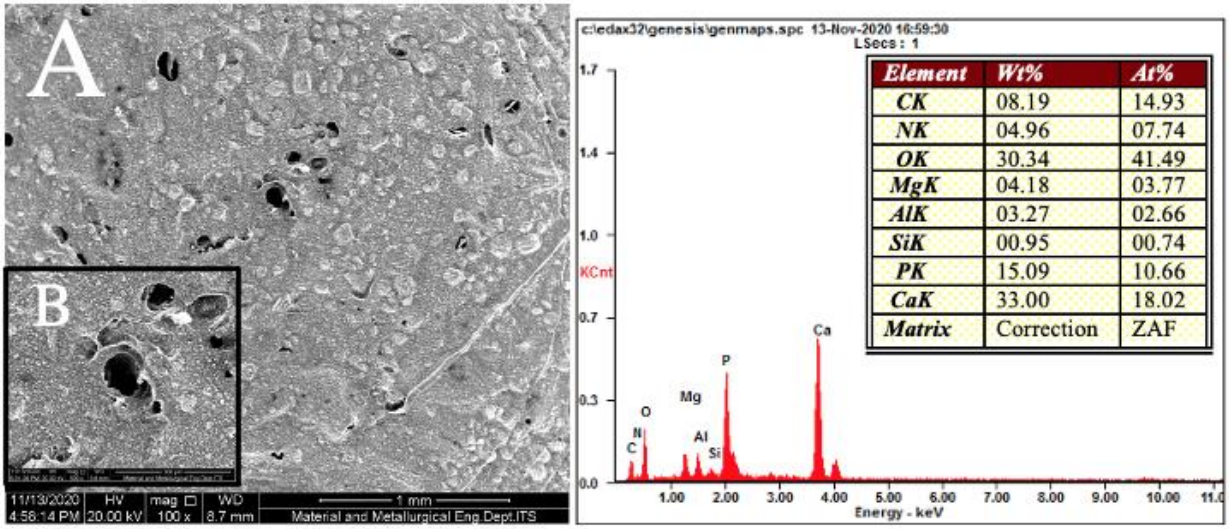


Fig. 5 - The SEM-EDX analysis shows the surface morphology and composition of the K-G/CHA30:70 (w/w) scaffold at 100x (A) and 500x (B) magnification

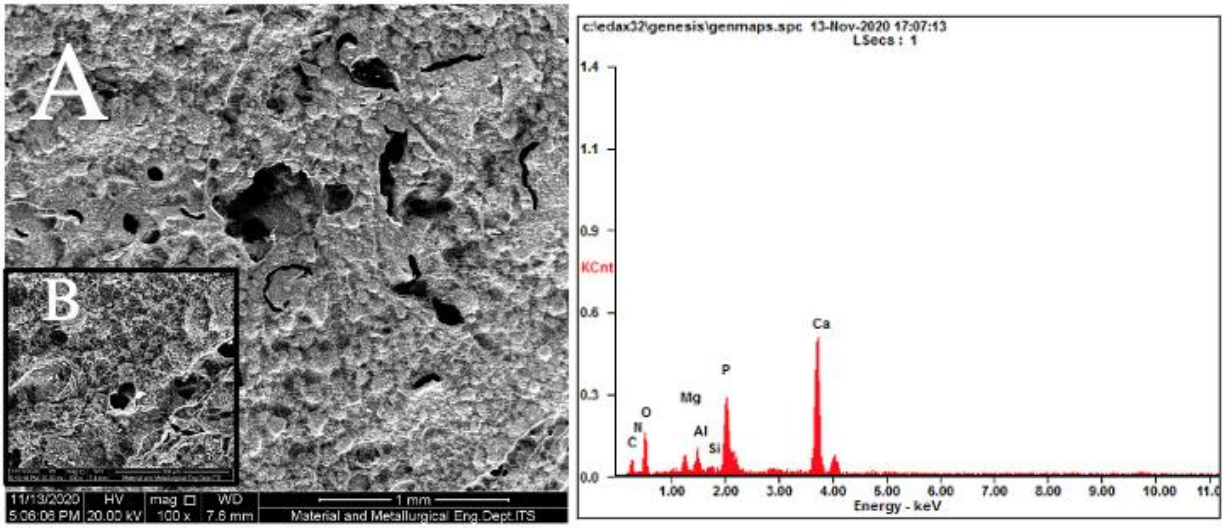
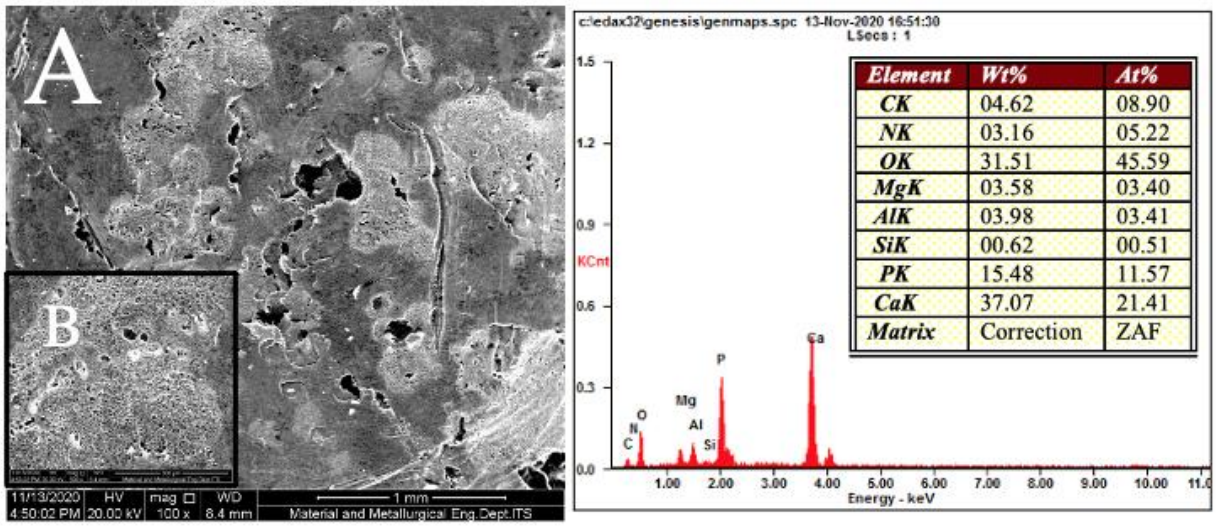


Fig. 6 - The SEM-EDX analysis shows the surface morphology and composition of the K-G/CHA20:80 (w/w) scaffold at 100x (A) and 500x (B) magnification



Element	Wt%	At%
CK	04.62	08.90
NK	03.16	05.22
OK	31.51	45.59
MgK	03.58	03.40
AlK	03.98	03.41
SiK	00.62	00.51
PK	15.48	11.57
CaK	37.07	21.41
Matrix	Correction	ZAF

Fig. 7 - The SEM-EDX analysis shows the surface morphology and composition of the K-G/CHA10:90 (w/w) scaffold at 100x (A) and 500x (B) magnification

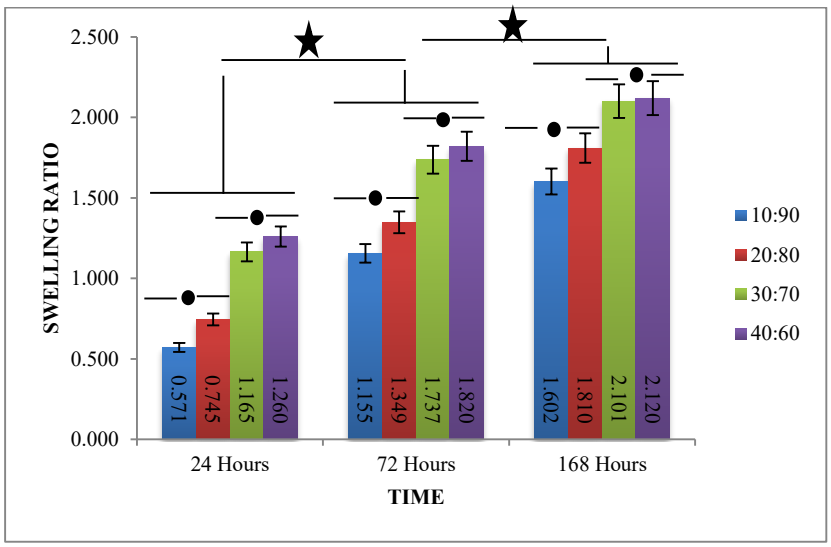


Fig. 8 - The swelling ratio for each K-G/CHA scaffold ratio at 24, 72, and 168 hours of immersion

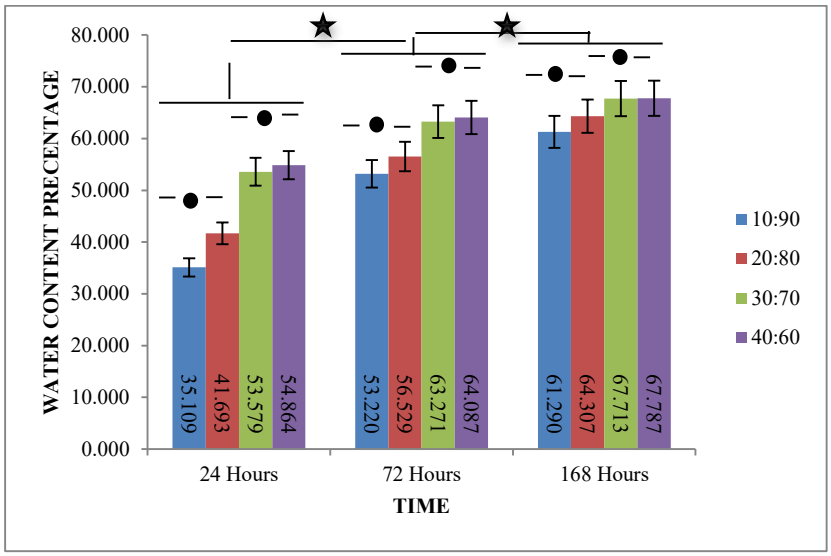


Fig. 9 - The water content percentage for each K-G/CHA scaffold ratio at 24, 72, and 168 hours of immersion

Figures 8 and 9 show that the less the CHA composition, the greater the swelling and WCP mean values. When immersed for 24, 72, and 168 hours, it showed that the longer the immersion duration, the more the swelling ratio and WCP were increased. The Saphiro-Wilk and Levene tests showed that the swelling data were normally distributed and homogeneous ($p > 0.05$), while the WCP data were not normally distributed ($p < 0.05$) but were homogeneous ($p > 0.05$). The one-way Anova and Kruskal Wallis tests showed that there were significant differences between each K-G/CHA scaffold ratio to swelling ratio (p = 0,000), and the WCP (p = 0,001) indicated that the higher the CHA composition, the lower the swelling ratio and WCP values. Furthermore, to determine which ratio had a significant difference, the Tukey HSD test for swelling and the Mann Whitney test for the WCP were obtained. There were significant differences in the swelling ratio and the WCP on the K-G/CHA scaffold ratios of 10:90, 30:70, and 40:60 and between the ratios of 20:80, 30:70, and 40:80. There was a significant difference between 24, 72, and 168 hours of immersion ($p < 0.05$).

4. Discussion

The spectra and FTIR peak values of the K-G/CHA scaffolds can be seen in Fig. 2, which shows the presence of hydroxyl groups (OH-) and indicates the involvement of the three biomaterials in the scaffold formation. The hydroxyl group (-OH) comes from the presence of hydrated inorganic compounds. The presence of the carbonate and phosphate groups were found in the CHA. The carbonate group is a marker of carbonate substitution in the apatite structure, while the phosphate group is a marker for the presence of minerals that support bone growth. A previous study showed the presence of hydroxyl, carbonate, and phosphate functional groups in carbonate apatite synthesized by the precipitation method [19]. These three groups were identified in the K-G/CHA scaffold, which indicates carbonate apatite involvement in the scaffold.

The presence of amide I, carboxylate, and amine groups could be identified in type B gelatin from bovine. Gelatin contains Arg-Gly-Asp (RGD) sequences, which are composed of several amino acids. Amino acids are organic compounds that contain amine and carboxylic functional groups, which can be identified from a FTIR band. RGD sequences support bone cell adhesion and migration [6], [20]. The involvement of gelatin in the K-G/CHA scaffold is characterized by the presence of an amide group I. Chitosan with a medium molecular weight has C-H, amide I, amide II, and amine groups. The C-H group is a marker of the polysaccharide structure of chitosan, while the hydroxyl and amine groups are reactive functional groups that increase the bonds between the biomaterials [20], [21]. Hydroxyl groups, C-H, amide I, amide II, and amine groups were found in commercial chitosan (Sigma-Aldrich) [22], [23]. The involvement of chitosan in K-G/CHA is characterized by the presence of amide groups I and amide II.

Amide I and amide II contain C-N groups that show the cross-linking between gelatin and chitosan, which forms the interconnectivity of the scaffold. The chitosan-gelatin complex shows structural similarities with glycosaminoglycans and collagen of an extracellular matrix. In addition, cross-linking between chitosan and gelatin improves the mechanical properties and pore interconnectivity of the scaffold [24]. An XRD analysis was carried out to determine the shape of the sample's particles (Fig. 3). The carbonate apatite obtained a clear pattern at each peak and high intensity, indicating that it has a crystalline form. The peak pattern of carbonate apatite is similar to synthetic hydroxyapatite (Sigma-Aldrich) because the carbonate apatite used in this study (CHA BBK) is carbonate ions (calcium carbonate and magnesium carbonate to form CHA) added to hydroxyapatite. The addition of carbonate ions causes changes in the crystal morphology and decreases the crystallinity, which thereby increases the solubility of the materials [25].

The pattern of the XRD analysis on the chitosan sample showed a wide diffraction peak at 2θ=10.01° and 20.05° then the intensity decreased (Fig. 2). This pattern indicates a semi-crystalline characteristic, and it has a dominant amorphous structure. The XRD pattern on the gelatin sample showed sloping diffraction between the peaks of 19.95°–41.66°, which indicated the presence of an amorphous form (Fig. 3). The results of the study were due to the sloping diffraction because of signals from the amorphous polysaccharides [26]. Former study also argued that there was a dominant amorphous structure in chitosan and the gelatin samples [6]. The XRD analysis was carried out on the K-G/CHA scaffold with ratios of 40:60 (w/w), 30:70 (w/w), 20:80 (w/w), and 10:90 (w/w) shows a firm peak pattern with high intensity and gentle peaks (Fig. 2). This shows that the form of the particle structure of the K-G/CHA scaffold is a crystalline and amorphous combination due to the presence of carbonate apatite, chitosan, and gelatin on the scaffold. The crystalline form is obtained from apatite carbonate, while the amorphous form is obtained from chitosan and gelatin.

The results of the SEM-EDX analysis can be seen in Fig. 3–7. A freeze-drying technique produces a scaffold morphology with a porosity of up to 90% [16]. The data from our unpublished data showed that the K-G/CHA scaffold with four ratios has a porosity of around 57.40%. The lower the polymer concentration, the higher the porosity percentage. This is because, at low polymer concentrations, the viscosity of the gel will be lower and contain more water. During the freeze-drying process, the water contained will sublimate and produce a larger pore size and porosity. The results of this study are following other studies that stated an increase in the percentage of porosity due to the reduction in the concentration of alginate as a polymer [27]. The porosity, which is suitable for application in the tissue engineering field, is around 50-90%. The scaffold with this porosity percentage shows the ideal pore interconnectivity for cell tissue growth, and it supports the osteoinduction properties [6], [28]. Based on these results, it can be concluded that it is feasible to apply the K-G/CHA scaffold with four different ratios in the field of tissue engineering due to the supports of cell growth.

A scaffold as a bone substitute material must have a micropore and macropore structure. Micropores (<50 μm in diameter) support osteoblast adhesion and growth factors, while macropores (>50 μm in diameter) support bone growth and bone tissue vascularization [29], [30]. The pores required for bone mineralization are at least 100 μm to provide a conducive environment for cell survival and bone remodeling. Moreover, micropores are required for bone maturation and formation [31]. Based on Table 2, it shows that there are micropore and macropore structures in the K-G/CHA scaffolds with a ratio of 40:60 (w/w), 30:70 (w/w), 20:80 (w/w), and 10:90 (w/w). According to previous research data, the pore size of around 50–300 μm allows for adhesion, growth, and migration of vascular tissue [15].

An EDX analysis is used to identify and measure the percentage of elemental composition contained in the scaffold [32]. CHA BBK consists of oxygen (O), magnesium (Mg), aluminum (Al), silicon (Si), phosphorus (P), and calcium (Ca). The K-G/CHA scaffolds with four different ratios consist of the same elements as CHA BKK, namely carbon (C), nitrogen (N), oxygen (O), magnesium (Mg), aluminum (Al), silicon (Si), phosphorus (P), and calcium (Ca). These results indicated the involvement of apatite carbonate in the K-G/CHA scaffold (Fig. 4–7). CHA on the scaffold plays a role in attracting calcium and phosphorus ions to induce osteogenesis [32]. The Ca/P ratio of adult bone tissue is 1.71, and hydroxyapatite is 1.67. It is considered to be the most effective ratio for bone regeneration [33], [34].

The atomic ratio of Ca/P in Table 3 was supported by other studies, which stated that carbonate apatite synthesized from calcium sulfate hemihydrate and calcium hydroxide obtained a Ca/P ratio of around 1.53–2.01 [35]. Based on the results of the study, the four different ratios meet the criteria for use in tissue engineering. A K-G/CHA scaffold with a ratio of 30:70 (w/ w) is considered the most optimal because it has a Ca/P ratio that is almost the same as the Ca/P ratio of hydroxyapatite by stoichiometry and bone Ca/P. After the swelling ratio and WCP analysis were conducted, it showed that the higher the CHA composition, the lower the swelling ratio and WCP values. This is probably because it used CHA derived from hydroxyapatite, which is a carbonate group substitution. Hydroxyapatite has the same chemical structure as nano-hydroxyapatite [$Ca_{10}(PO_4)_6(OH)_2$]. The CHA components affect the cross-linking between CHA with chitosan and gelatin. Nano-hydroxyapatite forms cross-links between chains and reduces the hydrophilicity of gelatin by binding calcium and phosphate to hydrophilic groups—COOH or NH2. Some NH2 from chitosan binds to calcium groups, and then the OH groups cannot form hydrogen bonds, which thereby reduces the swelling ratio of the scaffold [36], [37].

The swelling and water absorption is are also affected by the duration of immersion, where the values of the swelling ratio and WCP increase to the highest peak at 168 hours of immersion. The value of the swelling ratio and WCP is are also affected by the hydrophilic scaffold materials, namely chitosan, gelatin, and carbonate apatite [38–40]. At a high swelling ratio and high WCP values, the liquid is easier to penetrate the scaffold so that the scaffold degrades faster [41]. The scaffold was developed to be an efficient protein transport, which is not only in large quantities but also gradually [42]. The ability of the swelling affects the hydrophilic properties of the scaffold is important for the scaffold to carry calcium and phosphate ions into the scaffold for new tissue formation [43]. The values of the swelling ratio and WCP affects the hydrolysis and the physical properties, which are good for the scaffold in nutrient transport, which is important for the bone regeneration process [44]. Based on previous studies, it is stated that the swelling ratio and WCP can affect the hydrophilic properties of a scaffold. The higher the value of the swelling ratio and WCP, the better the hydrophilic properties. In our study, the highest swelling ratio value was obtained from a K-G/CHA scaffold with a ratio of 40:60, namely 2.120 ± 0.11, and the highest WCP value of 67.78% ± 1.21 was also obtained from the K-G/CHA scaffold with a ratio of 40:60. The K-G/CHA scaffold ratios of 40:60 and 30:70 have no significant difference; therefore, the two K-G/CHA scaffold ratios have the same properties. The K-G/CHA scaffold with a ratio of 30:70 was considered suitable because it is similar to the components of the bone extracellular matrix.

5. Conclusion

A K-G/CHA scaffold with four different ratios, 40:60 (w/ w), 30:70 (w/ w), 20:80 (w/w), and 10:90 (w/w) has the appropriate functional groups, the crystal and amorphous particles form, micropore, and macropore structures, and the same elemental content. A K-G/CHA scaffold with a ratio of 30:70 (w/w) has the most ideal ratio (1.69). A K-G/CHA scaffold with a ratio of 30:70 has an ideal value of the swelling ratio (2.10 ± 0.11) and WCP (67.71% ± 0.56).

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